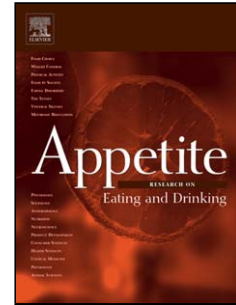


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## **Hunger inhibits negative associations to food but not auditory biases in attention**

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**Abstract**

Motivational state has been found to influence visual attentional bias and evaluation of food related stimuli. The study here aimed to extend this research to investigate whether such biases are also evident in the auditory domain and whether motivational state is associated with changes in the implicit evaluation of food words. Thirty participants, randomly allocated to a pre-lunch or post-lunch condition completed a Dichotic Listening Task (DLT) and Implicit Association Test (IAT). For the IAT, participants in the pre-lunch group were slower to associate food with unpleasant words than the post-lunch group, but motivational state did not affect detection of food words in the DLT. These findings suggest that implicit attitudes toward food can vary with motivational state.

**Keywords**

Food, Hunger, Motivational State, Attentional bias, IAT.

## Introduction

Research suggests that cognitive processes such as attention and memory are important influences in eating behaviour. For instance, (Higgs, 2002) found that participants who were prompted to recall lunch eaten that day subsequently ate fewer snacks than those who did not think about a recent meal, suggesting that memory for recent eating is factored into decisions about subsequent consumption. It has also been suggested that motivational-state-dependent eating may be influenced by attentional processes. For example, attention to food-related visual stimuli is heightened in a hungry relative to a sated state (Channon & Hayward, 1990; Mogg, Bradley, Hyare, & Lee, 1998). However, there has been less investigation of the effect of motivational state on attention processing of auditory stimuli. One aim of this study was therefore to investigate this issue using a Dichotic Listening Task (DLT) in which participants are required to shadow a prose passage presented to one ear (attended channel) while simultaneously detecting target words presented to the other ear (unattended channel). The use of a DLT has the advantage of being a naturalistic task that provides a more specific measure of selective attention than other paradigms such as the Stroop test (Stroop, 1935). Schotte, McNally, and Turner (1990) used the DLT to determine selective attention in bulimics. Results showed that bulimics detected a body-related word (fat) in the unattended passage more frequently than normal controls, a finding that is consistent with the suggestion that bulimia is associated with a bias toward processing body size and shape. However, no study to date has examined the effect of manipulated hunger state on detection of food words using the DLT in non-eating disordered individuals.

In addition to attentional resources being directed toward food stimuli in a hungry versus sated state, there is also some evidence that food items are evaluated as more pleasant when assessed using the Implicit Association Test (IAT) (Greenwald, McGhee, & Schwartz, 1998). In the IAT participants see stimuli that belong to one of four categories that are categorized by pressing one of two keys. Results show that responses are faster when associated categories are assigned to the same key than when they are assigned to different keys. It has been reported that participants are faster in categorising food words sharing the same response key as pleasant when hungry versus sated (Seibt, Hafner, & Deutsch, 2007). However, Seibt et al., (2007) allocated participants to either a hungry or sated state based on a median split of the number of self-reported hours since they had last eaten rather than directly manipulating hunger state. Additionally, the IAT that was used differed in a number of respects from other work. For instance, the food words used in the critical test blocks were different to those used in the training blocks and the counterbalancing of key assignments was limited to two rather than the four combinations used in other research (Field, Mogg, & Bradley, 2004). Therefore a second aim of the present study was to examine the effects of manipulated hunger state evaluation of food related stimuli using an implicit measure.

We predicted that individuals who had not eaten lunch would detect significantly more food versus control targets in the unattended condition of the DLT. For the IAT, we expected that compared with the group that had eaten lunch, those participants who had not eaten lunch would evaluate food words as more pleasant.

## Method

### *Participants*

Thirty staff and students of the University of Portsmouth (24 females, 6 males,) participated in the experiment, ages ranged from 21 to 50 years, mean age of 30.4 years (sd =7.4). Participants responded to an email describing a study examining factors influencing mood and attention. All participants were native English speakers and reported normal hearing. The protocol was approved by the University ethics committee. Participants in the two groups did not differ significantly in age (pre-lunch  $30.2 \pm 2.0$ , post-lunch  $30.6 \pm 1.8$ ), BMI (pre-lunch  $26.4 \pm 1.1$ , post-lunch  $25.3 \pm 0.9$ ) (both  $t < 1$ ) or in the number of males and females (both groups had 12 females and 3 males).

### *Design*

Participants were randomly allocated to a pre-lunch or post-lunch condition (using a random number procedure) and completed a Dichotic Listening Task (DLT) and Implicit Association Test (IAT). The study therefore used a mixed design where hunger state was studied between subjects (pre-lunch/post-lunch) and the words detected in the DLT and IAT response times within-subjects.

### *Word Stimuli*

A pilot study was completed to create a pool of words to be used in the study, where 16 females/males were presented with twenty food words and asked to rate how strongly they associate each word with satisfying a hungry state from '0' (not strong at all) to '10' (very strong). From these responses, the highest rated words were selected as food target words; five for the IAT, and one, 'pizza', for the DLT target word (control word 'taxi'). The IAT contained four categories: food, furniture, pleasant and unpleasant with each category containing five words associated to that category. The

words for food were: sandwich, curry, banana, pasta, pudding, and for furniture: curtains, table, carpet, armchair, and mirror. The pleasant words were selected from an earlier IAT study (Huijding, de Jong, Wiers, & Verkooijen, 2005)

### ***Dichotic Listening Task (DLT)***

This version was similar to that used in a previous study (Schotte, McNally, & Turner, 1990). Six different audio files were constructed, each consisting of two different prose passages, one presented to each ear and read by the same female voice (native English speaker) at approximately 120 words per minute. Two versions of the practice file were constructed, which were identical except in one version, one of the passages was presented to the attended ear which was reversed in the second version, i.e. presented to the unattended ear. In the test itself, two passages for the five-minute experimental and neutral audio files were taken from the BBC news website<sup>2</sup>. The target words ‘pizza’ and ‘taxi’ occurred ten times out of context in each passage of the experimental and neutral audio files respectively. Two versions of the experimental and neutral audio files were created, which differed only in that one of the passages was presented to the attended ear which was reversed in the second version, i.e. presented to the unattended ear. The target words occurred at random intervals between words 50 and 500 of the 550 word passages, with the constraint that they had to be separated by at least ten words, both within and between channels. The DLT lasted approximately fifteen minutes.

### ***Implicit Association Task (IAT)***

The IAT used here was closely based on that used in previous work (Field et al., 2004), where words were presented individually on a computer screen, remaining until

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<sup>2</sup> <http://news.bbc.co.uk/1/hi/education/5282646.stm>, <http://news.bbc.co.uk/1/hi/uk/6154186.stm>

participants made a response. The task was divided into five blocks of different lengths. Blocks 1 and 2 were practice blocks for the pleasant & unpleasant, food & furniture categories respectively, where in each block 20 words were presented, with each word presented twice. To illustrate the task using block 1 as an example, participants were instructed to categorise the word by pressing the left key ('z') for a 'pleasant' word and the right key ('m') for an 'unpleasant' word (dependant on IAT version, see below) as quickly and accurately as possible. Reminders of these key allocations were always present at the top of the screen. They were further advised if they made a mistake, they would see an 'X' briefly displayed. These instructions were the same for all blocks (with relevant category and key allocation). Block three was a critical block, where the 80 words were presented from all four categories, with each word presented four times. In this block, participants were instructed to press one key, e.g. the left key for a 'pleasant' or 'food' word and the right key for a 'unpleasant' or 'furniture' related word. Block four was a further practice block analogous to block one, however now category/key assignments for the pleasant and unpleasant words were switched. Block five was the second critical block, with the same structure as block 3. Within each block, words were presented in a random order. To control for any biases in hand preference and associated category, participants were assigned to one of four different versions of IAT, and each version in turn was counterbalanced across groups and participants. The versions differed in which key was assigned to the food related category (either left 'z' or right 'm' key) which remained constant for all blocks of the task and which key was assigned initially to the pleasant category, being reversed in blocks 4 and 5. The IAT lasted approximately fifteen minutes.



***Mood and Hunger Ratings***

Ratings of hunger were made using 100mm unmarked line scales end-anchored “Not at all” and “Extremely”, with the adjective ‘hungry’ centred above the line. In addition to this adjective, other mood adjectives were also used (‘alert’, ‘happy’, ‘drowsy’), mainly to divert attention away from the real purpose of the study, but also to provide data on how temporary suspension of lunch might affect behaviour.

***Procedure***

Participants in the post-lunch condition were asked to have consumed their lunch no longer than one hour prior to the start of the experiment. Participants in the pre-lunch condition were required to consume their normal breakfast no later than 8.30am and after this to consume only water (i.e. no other food) until they had completed the study. The testing was always scheduled between 12.30 and 1430. Upon arrival participants were asked to complete a diary of food consumed that day (to check compliance) followed by the completion of a brief mood questionnaire. Participants then completed the DLT and IAT followed by a second mood questionnaire. In order to control for its possible influence on the DLT, participants were then asked to rate the degree to which they liked the food ‘pizza’ from ‘0’(not at all ) to ‘10’ (extremely). Following this, they were given a debriefing, thanked and paid five pounds for their participation.

***Data analysis***

For the DLT, the number of correct detections were entered into a repeated-measures ANOVA, using the within-subjects factor of Word type (pizza/taxi) and the between-subjects factors of Group (pre-lunch/post-lunch) and Order (experimental/neutral, neutral/experimental). This analysis was completed separately for attended and unattended channels. The IAT data were analysed by removing incorrect responses and

outlying reaction times of less than 200ms and more than 2000ms and then removing those times that were more than 2sd from the mean. The remaining data were entered into a repeated-measures ANOVA using the within-subjects factors of Block (food + pleasant/food + unpleasant) and the between-subjects factors of Group (pre-lunch/post-lunch) and IAT order. Baseline mood and hunger data were analysed using independent t-tests. One participant failed to provide pizza liking ratings, and therefore analysis for this measure was completed with the remaining twenty-nine participants.

## Results

Analysis of baseline hunger revealed as expected significantly higher ratings for the pre-lunch ( $67.9 \pm 3.0$ ) compared to post-lunch ( $9.4 \pm 2.1$ ) group [ $t(28)=15.66$ ,  $p<.0001$ ].

Additionally, ratings for drowsy were significantly lower for those pre-lunch ( $28.8 \pm 6.0$ ) versus post-lunch ( $48.8 \pm 6.4$ ), [ $t(28)=2.25$ ,  $p<.05$ ], presumably due to a 'post lunch' dip in arousal in those who consumed lunch. A marginal effect was also found in ratings of happy, being less for pre-lunch ( $64.2 \pm 5.3$ ) compared to post-lunch ( $76.8 \pm 3.3$ ) participants [ $t(28)=1.99$ ,  $p=.06$ ]. The analysis of the liking ratings for pizza revealed an effect that approached significance [ $t(27)=1.86$ ,  $p=.07$ ], with higher ratings for those in the pre-lunch ( $7.7 \pm 0.4$ ) versus post-lunch group ( $6.1 \pm 0.7$ ).

For the DLT unattended channel, ANOVA revealed a significant main effect of Word, [ $F_{1,26}=4.60$ ,  $p<.05$ ], where more detections were made of taxi ( $3.7 \pm 0.4$ ) compared to pizza ( $2.8 \pm 0.4$ ). Against prediction the Word x Group interaction was not significant ( $F<1$ ). In the attended channel there were no significant effects, with near perfect levels of detection for both taxi ( $9.6 \pm 0.1$ ) and pizza ( $9.6 \pm 0.1$ ).

Analysis of IAT data revealed a significant main effect of Block [ $F_{1,22}=77.81$ ,  $p<.0001$ ], where responses were faster in the food + pleasant ( $733.60 \pm 27.46$ ) compared to food + unpleasant ( $850.32 \pm 29.71$ ) block. There was also an interaction between Block and IAT order [ $F_{3,22}=6.19$ ,  $p<.01$ ], which was explained by the fact that although all order conditions demonstrated the same pattern (faster responses for food + pleasant versus unpleasant), the effects were stronger in the orders 1 and 4, where food and pleasant shared the same response key in the first block, which seems likely to be a known artefact of the task (Greenwald et al 1998). Importantly, consistent with prediction there was a significant interaction of Group x Block [ $F_{1,22}=5.97$ ,  $p<.05$ ], where mean comparisons revealed that although reaction times were faster in both groups for the food + pleasant compared to food + unpleasant block, the magnitude was greater for the pre-lunch versus post-lunch group (Figure 1). Post-hoc analyses demonstrated this difference between the two blocks was significant for both the pre-lunch [ $F_{1,14}=42.60$ ,  $p<.0001$ ] and post-lunch groups [ $F_{1,14}=14.56$ ,  $p<.01$ ].

-Insert Figure 1 About Here-

## Discussion

This study found that participants who had not eaten lunch were significantly faster than a group that had eaten lunch in categorising food words sharing the same response key with pleasant words compared to when food words shared the unpleasant response key. This indicates the food related words were perceived as implicitly more positive for individuals in a high versus low hunger state relative to implicit negative perception of food words. This result is consistent with the findings of (Seibt et al., 2007) although these authors found that only participants labelled hungry and not satiated evaluated

foods as more positive, whereas we found that all participants showed an implicit positive evaluation for food words. There are a number of factors that may account for this difference. It may be that unlike the earlier study where hunger state was determined by a median split of the number of hours since participants had last eaten, the greater control over hunger state in the present study permitted a more accurate assessment of how valence for food changes with hunger state. Hence, individuals recently consuming a meal may still in fact have positive associations with food stimuli. Alternatively, these contrasts are due to some aspect of the different IAT versions in each study. Nevertheless the findings here are generally consistent with those of the previous study (Seibt et al., 2007) and confirm the usefulness of the IAT in food related work.

In the DLT, detection of food related targets did not differ between the experimental groups, which was against prediction. One possibility to account for these results could be the observed superior detection for control versus target words in the unattended channel, which may have obscured any group differences and was not reported in previous DLT work (Schotte et al., 1990). Hence the use of more equally detectable target and control words may have lead to different results and should be addressed in future work. Another consideration is the length of time participants in the no lunch group went without food (4-6 hrs), being less than some previous work (Channon & Hayward, 1990) and whether this may explain the absence of an effect in the present study. Nevertheless, the demonstration here of significantly higher hunger ratings in the pre-lunch compared to post-lunch group would appear to suggest this may not be the main reason.

In terms of the limitations of the present study, since the tasks were completed in a fixed order (DLT then IAT), there remains the possibility of an order effect. Nevertheless one alcohol related study (De Houwer, Crombez, Koster, & De Beul, 2004) that also used the IAT after another task found highly similar findings to previous work where the IAT was completed first (Wiers, van Woerden, Smulders, & de Jong, 2002), suggesting that effects of task order on the IAT would be negligible. However this cannot be discounted completely and future work should examine this issue. Additionally, since work has shown that the level of dietary restraint can predict attentional bias to food related words (Green & Rogers, 1993), it could be that including this factor in the present study would have revealed differences in the DLT and possibly IAT and therefore calls for additional research.

In summary, the findings here suggest that for individuals in a hungry state, food stimuli are less easily associated with unpleasantness compared to those in a satiated state. Though we did not find an effect of hunger state on auditory attention for food words using a modified DLT task, this area warrants further investigation.

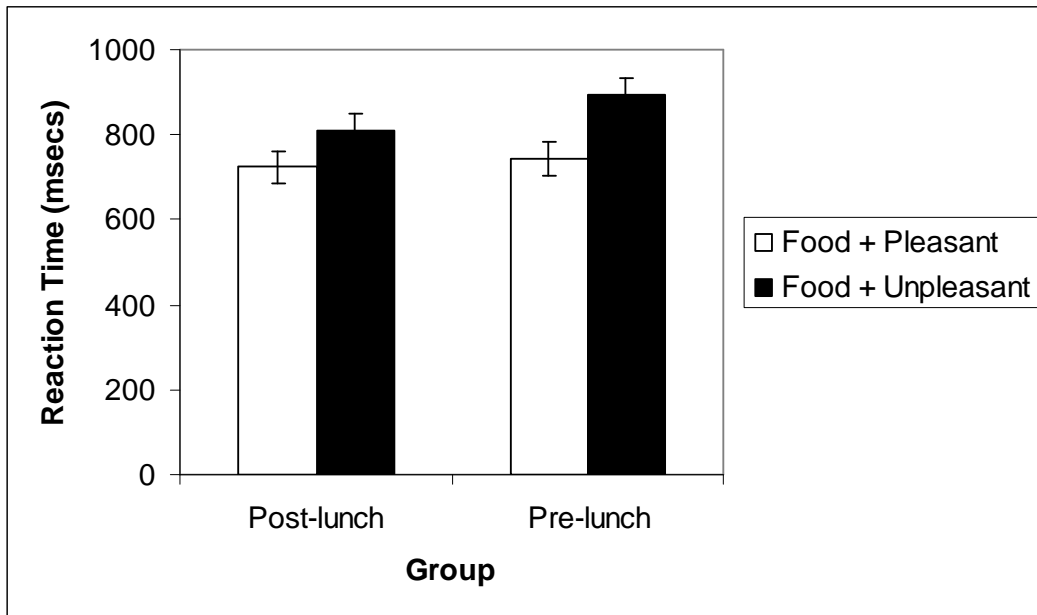
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**Legends for figures:**

Figure 1 Mean IAT reaction times (in ms with standard error bars) dependent on block and group

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